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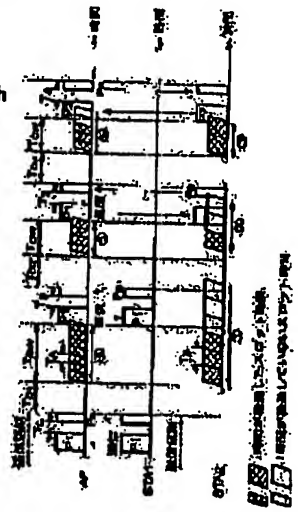
(54) WIRELESS PACKET PRIORITY CONTROL METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To solve a problem of a conventional wireless packet priority control method adopting a method for deciding transmission priority with a random number in the case of setting a collision avoidance period has had a deteriorated frequency utilizing efficiency because a data packet with low priority has a wait time without fail even when a data packet with high priority is not in existence.
SOLUTION: This invention provides a wireless packet priority control method that realizes priority control of a data packet of an 'excellent effort type' by adopting a method where a collision avoidance period Tcw consisting of a multiple of basic unit times (slot times) is obtained by multiplying the slot times selected sequentially shorter for data packets with high priority ranking information with a random number without changing a distribution range of the random number, or a method where some waiting slots are inserted to a set collision avoidance period, or a method where the distribution range of the random number is changed to insert a fixed wait slot to a head of the collision avoidance period so as to set the length of the collision avoidance and a carrier sense method in response to the priority of transmission data.



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CLAIMS

[Claim(s)]

[Claim 1] It is in the base transceiver station connected to a cable network, this base transceiver station, and a dependency. Consist of two or more radio stations which perform wireless packet communication, and said base transceiver station and the radio station of said large number use a common radio channel, and the propriety of transmission is mutually judged independently at the time of a communication link. The collision of a packet is avoided. In the wireless packet priority-control approach in the wireless packet communication which performs the contention access control based on CSMA/CA (Carrier Sense Multiple Access Collision Avoidance) which transmits a wireless packet If a data packet including the priority information which shows the height of the priority in the inside of the best effort type which should perform transmitting processing within the contention access-control section is received, said base transceiver station and said radio station Memorize, while acquiring this priority information, and before the data transmission by said contention access control In a setup of the collision-avoidance period (Contention Window) which consists of a multiple of base unit time amount (slot time) The wireless packet priority-control approach that a data packet with the higher priority information on said memorized data packet is characterized by setting up said slot time short.

[Claim 2] It is said wireless packet priority-control approach according to claim 1. The higher data packet of the priority of the priority information on said memorized data packet When setting up said collision-avoidance period short, the slot time over the high data packet of said priority is set up shorter than the slot time over the low data packet of priority. The wireless packet priority-control approach characterized by setting up the time amount which multiplied by said random-number value acquired using the random number, respectively as a collision-avoidance period.

[Claim 3] It is the wireless packet priority-control approach according to claim 1. The higher data packet of the priority of the priority information on said memorized data packet When setting up said collision-avoidance period short, it considers as the time amount which multiplied by the value which used the random number for the slot time which defines beforehand the collision-avoidance period over the data packet of the highest priority, and was acquired. As opposed to the data packet of other priority To the time amount which multiplied by the random-number value which used the random number for the slot time defined beforehand, and was acquired The wireless packet priority-control approach characterized by setting up the time amount which added 1 slot time for every N (N integer) slot time as a collision-avoidance period, and enlarging the value of N, so that the priority of the data packet is high.

[Claim 4] It is the wireless packet priority-control approach according to claim 1. The higher data packet of the priority of the priority information on said memorized data packet When setting up said collision-avoidance period short, the minimum value and maximum of the value which the random number made to generate a random-number value can take The thing to the high data packet of priority sets up smaller, and it considers as the time amount which multiplied by the value which used said random number for the slot time which defines the collision-avoidance period over a data packet beforehand, and was acquired, and from the collision-avoidance time amount at the time of the 1st back-off control of data packets other than the highest priority To the time amount which lengthened the collision-avoidance period which the data packet of the highest priority spent The wireless packet priority-control approach characterized by setting up the time amount which added the time amount which multiplied by the slot time beforehand set to the **** value of said random number as collision-avoidance time amount at the time of the next back-off control, and repeating this until it transmits a data packet.

[Claim 5] The base transceiver station which said radio station transmitted the priority information on the data packet which transmits before the data transmission by said contention access control by the communication packet to said base transceiver station when it was the wireless packet priority-control approach according to claim 2 and said base transceiver station HEDETA packet was transmitted from said radio station, and received this communication packet is the wireless packet priority-control approach characterized by to notify corresponding slot time to said radio station by the communication packet based on the priority information on this data packet.

[Claim 6] The base transceiver station which was the wireless packet priority-control approach according to claim 3, and said radio station transmitted the priority information on the data packet which transmits before the data transmission by said contention access control by the communication packet to said base transceiver station, and received this communication packet when said base transceiver station HEDETA packet was transmitted from said radio station is the wireless packet priority-control approach characterized by to notify the value of said N to said radio station by the communication packet based on the priority information on this data packet.

[Claim 7] When it is the wireless packet priority-control approach according to claim 4 and transmits said base transceiver station HEDETA packet from said radio station, said radio station The base transceiver station which transmitted the priority information on the data packet which transmits to said base transceiver station by the communication packet, and received this communication packet before the data transmission by said contention access control The wireless packet priority-control approach characterized by notifying the minimum value and maximum of said random-number value to said radio station by the communication packet based on the priority information on this data packet.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the wireless packet priority-control approach which makes possible the priority control which started wireless LAN, especially distinguished the packet in within the limits of a best effort type.
[0002]
[Description of the Prior Art] Generally, as a wireless access method, the access method in the wireless LAN system specified in IEEE 802 Committee is typical.
[0003] This convention is described by the detail at "IEEE802.11, Draft Standard for Wireless LAN Medium AccessControl(MAC) and Physical Layer(PHY) Specification, P802.11D 8.0, 1 May 1998." Hereafter, this convention is called as "IEEE802.11 specification" and explained.
[0004] The access method of a MAC layer is described in "IEEE802.11 specification."
[0005] Here, about the contention access control, while two or more STAs (radio station) of a base transceiver station (AP) and a subordinate carry out carrier sense so that the collision of a packet may not arise, DCF (Distributed Coordination Function decentralized control procedure) using the CSMA/CA (Carrier Sense Multiple Access Collision Avoidance) method which transmits data is used.
[0006] Drawing 5 shows the communication link actuation to the time amount in DCF which "IEEE802.11 specification" is shown. In this drawing, two radio stations (STA is called hereafter) which carry out wireless packet communication are shown by making an axis of abscissa into the passage of time, for example, the actuation after data transmission of STA1 is completed is shown.
[0007] Here, in "IEEE802.11 specification", IFS (Inter Frame Space) is the time amount of carrier sense for AP and STA to get to know the condition of a wireless medium, and four kinds such as SIFS (Short IFS), PIFS (PCF(Point Coordination Function) IFS), DIFS (DistributedIFS), and EIFS (ExtendedIFS) are specified in the short order of time amount, i.e., the high order of the priority of access. In addition, DIFS used as the carrier sense time amount in the case of transmitting a data packet signal relates to this invention.
[0008] Here, data transmission is performed from STA1 to AP at time of day T, and it is assumed that AP and STA2 suited the transmitting standby condition.
[0009] First, STA1 transmits data P1 to AP, and after receiving from AP the ACK packet (Pa) which answers reception of that, AP and STA2 stand by until they carry out (TD) progress between DIFS(s).
[0010] And the collision-avoidance period (Contention Window:Tcw) used as random time amount is given to each of AP and STA2. This collision-avoidance period is searched for by the multiplication of base unit time amount and a random number so that it may mention later.
[0011] AP and STA which have the data packet which should transmit as the Ruhr in [whole] all STAs containing AP subtract the random number which the integer of a certain range distributes uniformly in the decision of this collision-avoidance period. And the base unit time amount (slot time) of a collision-avoidance period is spent on the acquired random-number value, and the collision-avoidance period Tcw comes.

[0012] Transmission is started if a wireless medium does not become a busy after this period progress. In drawing 6 , 1 slot time (the number of 1 slots) is illustrated with one coma, in this example, the collision-avoidance period of 4 coma x slot time is given to AP, and the collision-avoidance period of 7 coma x slot time is given to STA2. Also in the drawing of this invention explained henceforth, it is the same. Since it is short compared with STA2, AP becomes preferential and the collision-avoidance period Tcw of given AP transmits data to STA1 from AP after this collision-avoidance period (4 slot time) progress. Transmission of STA2 at this time is postponed.
[0013] Furthermore, the ACK (Pa) transmission to AP is ended, and further, after DIFS(TD) period progress, since Tcw in the back off of STA2 becomes the shortest shortly, STA2 becomes data ready-for-sending ability. The collision is ensuring little packet transmission to the bottom of a race condition by the above sequences.
[0014] The RANDEMU back off used as the latency time after the DIFS progress mentioned above is actuation for reducing the collision between STAs which are going to transmit to coincidence probable, and the latency time in this back off hits at a collision-avoidance period.
[0015] In order for two or more STAs which have data which should be transmitted to prevent transmitting to coincidence by carrying out standby of a different collision-avoidance period acquired with the random number, respectively before data transmission, they become possible [preventing the collision of a data packet].
[0016] Drawing 6 is drawing for explaining the another conventional approach.
[0017] In this conventional example, although are concerned, there is nothing in the importance of data and the collision-avoidance period Tcw was given at random with the conventional technique mentioned above, priority attachment is performed to the die length of the collision-avoidance period Tcw, and the priority control according to the priority of a data packet is performed because the random number which STA with the data packet which transmits subtracts changes that range not according to uniform distribution but according to the priority of a packet which should be transmitted.
[0018] This example shows what communicates by AP and the radio station (STA1, STA2) of two games sharing the same frequency, and AP has the data packet P2 over which priority is un-given to STA2 in the packet data P1 with which priority is given to transmission compared with AP after packet transmitting termination of STA1, and has these Requests to Send. 5(fixed value)+0-5 [0-5 are assigned to this data packet P1 for slot time and / slot time / **********], i.e., the slot time of 5-10 is in a data packet P2. In this case, since a data packet P2 has priority lower than P1, 5 slot time surely turns into the latency time.
[0019] After STA1 receives the ACK packet to own data transmission, after both AP, STA1, and STA2 pass between DIFS(s) (TD), a procedure moves from them to the back off. Under the present circumstances, in determining the collision-avoidance period Tcw which is a period of the back off, each of STA and AP subtracts a random number, but weighting is made according to the priority of the packet of data which should transmit the integer range over which this random number is distributed.
[0020] By **, since priority is lower than a data packet P1, specifically, for example, "6" slot time is given for a data packet P2 from between 5-10 as the packet transmitting latency time. ** The waiting slot time in the last back-off control is "4", and this is smaller than "5" of the slot time which must be made into the latency time. For this reason, the waiting slot time in this back off is again set to "6." ** Set, the waiting slot time in the last back-off control is "3", and this is smaller than "5" of the slot time which must be made into the latency time. For this reason, the waiting slot time in this back off is again set to "6." ** "4" has been obtained from between transmission of a data packet P1 to 0-5. ** Value "3" has been obtained from between 0-5 as waiting slot time for transmission of a data packet P1.
[0021] In the case of drawing 6 [such], the priority of transmission is determined with reference to the header information in the head of the data which should be transmitted etc. And in order that AP may transmit the high packet of priority and 0-5, and STA2 may transmit the packet with low priority as for the range of a random number, the range of a random number is set up with 5-10. Thus, in order that STA2 which is going to transmit the low data packet of priority

may wait [in / slot time / 5 / in the minimum / ** back-off control], the data packet of AP will surely be transmitted in advance of STA2.

[0022] As mentioned above, the priority control within a contention access-control DCF period becomes possible by changing the range of a random number according to the priority of a data packet.

[0023]

[Problem(s) to be Solved by the Invention] The priority control set as the object of this invention has a typical method using the priority class specified in IEEE 802 Committee. This convention is described by the detail at "IEEE P802.1D Annex H, Design Consideration for Traffic Class Expediting and Dynamic Multicast Filtering, P802.1D, 25 May 1998." Hereafter, this convention is called "IEEE P802.1D specification."

[0024] Although the class which asks for "a positive guarantee" of qualities of service [class / in "IEEE P802.1D specification" / priority], such as a guarantee of the maximum time delay or a guarantee of bandwidth, here, and a guarantee are not needed, they are divided roughly into a "preferential BESUTOETO mold" class with priority higher than a best effort type (excellent effort mold). The priority control in this invention is the type of the latter which performs control according to the priority in the inside of a best effort type.

[0025] Here, in DCF in "IEEE 802.11 specification", the period "Contention Window" required in order to make a contention access control without a collision possible by applying the integer given to the number of slots which is the fixed-length conventional time with the generated random number is set up.

[0026] By the way, in order to perform the priority control according to that priority to a data packet with priority, in the wireless access method which gave semantics, priority attachment is needed but for transmitting spacing of data to a setup of Tcw, and in the decentralized control DCF based on CSMA/CA, since it sets it as the main purposes to give "a fair access opportunity", this priority attachment is not performed.

[0027] That is, since the die length of the collision-avoidance period Tcw is set up taking advantage of the random nature of a random number which made it generate from the integer which distributes uniformly the slot time which is the conventional time of the back off by considering as fixed time, the way things stand, control to the priority of a packet cannot be performed.

[0028] Moreover, there is a method of changing the integer range over which it is distributed according to the priority of a data packet to the random number subtracted in the case of a collision-avoidance period Tcw setup as the priority-control approach based on DCF as which the former which was mentioned above is proposed.

[0029] However, it must wait for 5 slot time of the collision-avoidance period in the range where the low data packet of priority is prepared for the high data packets of priority after DIFS termination even when the high data packet of priority does not exist, for example, drawing 6 , by this approach. The unnecessary latency time will exist by this and there is a problem of causing decline in frequency use effectiveness.

[0030] Furthermore, in a setup of the non-competing access period by the centralized control of AP, to QA of a priority control and a communication link being attained, by DCF which offers the contention access period by distributed cooperative control, even if it can perform a perfect priority control, carrying out to a guarantee of communication link quality has the trouble that it is difficult and the features of each control approach of PCF and DCF cannot be utilized thoroughly for this reason.

[0031] Then, this invention aims at offering the wireless packet priority-control approach in which the features of the "fairness of access" which a contention access control has which solve the trouble that the priority control which followed the priority of data by performing a setup of the collision-avoidance period Tcw based on the random random number is not made, and are not in the priority control within the DCF period by which the conventional proposal is made were made to reflect more.

[0032]

[Means for Solving the Problem] The base transceiver station connected to a cable network in

order that this invention may attain the above-mentioned purpose, Are in this base transceiver station and a dependency, and consist of two or more radio stations which perform wireless packet communication, and said base transceiver station and the radio station of said large number use a common radio channel, and the propriety of transmission is mutually judged independently at the time of a communication link. The collision of a packet is avoided. In the wireless packet priority-control approach in the wireless packet communication which performs the contention access control based on CSMA/CA (Carrier Sense Multiple Access Collision Avoidance) which transmits a wireless packet If a data packet including the priority information which shows the height of the priority in the inside of the best effort type which should perform transmitting processing within the contention access-control section is received, said base transceiver station and said radio station Memorize, while acquiring this priority information, and before the data transmission by said contention access control The wireless packet priority-control approach that a data packet with the higher priority information on said memorized data packet sets up said slot time short is offered in a setup of the collision-avoidance period (Contention Window) which consists of a multiple of base unit time amount (slot time).

[0033] Even if a large random number is given to the one where the priority of a data packet is higher by such wireless packet priority-control approach by setting the one where the priority of data is higher as short time amount for slot time, as for the die length of a random collision-avoidance period (Contention Window:Tcw), the probability which becomes short becomes high, and a data packet with priority high as a result is transmitted previously.

[0034]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail with reference to a drawing. First, with reference to the flow chart shown in drawing 2 , the concept of the wireless packet priority-control approach by this invention is explained. The communication link of this invention consists of a base transceiver station (AP) connected to a cable network, and a radio station (STA) which is in this AP and dependency and carries out wireless packet communication, and AP and all STAs are using the common radio channel.

[0035] Under the present circumstances, the period which performs the contention access control based on the CSMA/CA (Carrier Sense Multiple AccessCollision Avoidance) method of judging the propriety of transmission autonomously mutually, permitting the collision of a packet, and transmitting a wireless packet, and the non-competing access control by AP polling is repeated a fixed period, and wireless packet communication is performed by directing by the control information which AP reports that this period and period are.

[0036] First, AP will check the priority of a data packet, if a data packet including the priority information on data that it arrived from the cable network side is received (step S1) (step S2). A data packet is inserted in the queue corresponding to the priority checked here (step S3). Here, it judges whether it is the data packet which asks for QA (step S4), and if it is the data packet which asks for QA by this decision (Yes), it shall be a QA mold (a band guarantee and time delay guarantee) (step S5), and will transmit to the wireless terminal STA by centralized control PCF (step S6).

[0037] On the other hand, in not being the data packet which asks for QA, it judges whether it is the packet (excellent effort mold) which should transmit more preferentially than (No) and a best effort type (step S7).

[0038] By this decision, if it is not the packet which should transmit more preferentially than a best effort type, it will be recognized as what is (No) and a best effort type (step S8), and a random collision-avoidance period (Contention Window:Tcw) will be given as usual to each of AP and STA2. Let this collision-avoidance period be the collision-avoidance period Tcw over the base unit time amount (slot time) in the random-number value and collision-avoidance period which were lengthened from a certain range.

[0039] And it judges whether a radio frequency is intact after progress of a DIFS (TD) period (step S9), and if the radio frequency is intact (Yes), as soon as the given collision-avoidance period will become zero (step S10), it transmits (step S11). Moreover, in decision of said step S7, when it is the packet which should transmit preferentially rather than a best effort type, it recognizes as (Yes, i.e., an excellent effort mold) (step S12).

[0040] Tcw which is explained with the operation gestalt mentioned later in this excellent effort mold By setting up die length short, it sets up so that the probability for random collision-avoidance time amount to become short may become high by the approach of performing priority attachment by the back-off control period mentioned later (step S13).
[0041] And it judges whether a radio frequency is intact after progress of a DIFS (TD) period (step S14), and if the radio frequency is intact (Yes), as soon as the given collision-avoidance period will become zero (step S15), it transmits (step S16). If a data packet including the priority information which shows the permission transfer delay time amount and the necessary minimum bandwidth of the data with which AP specifically arrived from the cable network side is received, a data packet with such priority is transmitted to the purpose terminal in the PCF period which is a non-competing access-control period, and when a data packet including the other priority information is received, it will transmit to the purpose terminal in a contention access-control period. Here, if a data packet including the priority information which shows the height of the priority within the best effort type which should perform transmitting processing within the contention access-control section is received, AP will be memorized while it acquires said priority information.
[0042] Furthermore, if the wireless circuit is vacant before transmitting the data based on a contention access control, a random number will be subtracted, and the probability which the high packet of priority can transmit to order first by shortening the die length of the slot time from the high class of priority is made high in a setup of the collision-avoidance period Tcw of standing by only the value.
[0043] Furthermore, in case the terminal which is going to transmit the low data packet of priority to a setup of the collision-avoidance period Tcw of DCF control in a collision-avoidance period Tcw setup of a contention access control as the 2nd method of performing priority attachment performs carrier sense of the slot time basis in back-off control, originally it inserts the latency time (waiting slot) of the slot time basis still more nearly excessive N times for every number slot other than the assigned slot time.
[0044] The probability that the high packet of priority can be first transmitted for the time amount from which the collision-avoidance period Tcw of the terminal which is going to transmit the low data of priority by this serves as zero as a result of [its] lateness is made high.
[0045] Moreover, the part which the range overlaps mutually by the priority of a data packet in the generating range of the random number which each STA subtracts is left and determined as an approach of performing priority attachment, in a setup of the collision-avoidance period Tcw of DCF control in the case of a collision-avoidance period setup by the contention access control, and the random number assigned from each integer range is determined.
[0046] Furthermore, it considers as a collision-avoidance period by multiplying the slot time which is not concerned with priority but has a fixed value in the subtracted random number. And the terminal which is going to transmit the low data packet of priority The time amount of the value which imposed slot time on the minimum value in the range of the subtracted random number is set to ** back-off control. Surely Waiting, When other STAs transmit data during a collision-avoidance period, the data transmission from the end of a local is interrupted. When it waits for the collision-avoidance period of a next contention access-control period exceeding the time amount for which it must wait in ** back-off control, the probability that the high packet of priority can be transmitted first is made high by reducing only the part of the number of slot time for which it exceeded and waited.
[0047] Moreover, when there is a data packet Request to Send of the going-up direction from STA to AP, in advance of transmission of a priority data packet, STA transmits the priority of the packet which transmits to AP as a communication packet. And AP which received the communication packet determines the die length of the basic time-basis time amount of the collision-avoidance period permitted to this STA, and transmits a connection packet to STA by return [time amount / the / base unit].
[0048] Moreover, when there is a data packet Request to Send of the going-up direction from STA to AP, in advance of transmission of a priority data packet, STA transmits the priority of the packet which transmits to AP as a communication packet. And AP which received this

communication packet determines insertion spacing of the waiting slot time in Tcw permitted to this STA corresponding to the priority of a packet, or the generating range of a random number, turns up the setting information on Tcw, and transmits by the communication packet to STA.
[0049] As mentioned above, the priority control of the data packet of an "excellent effort mold" is realizable to a "best-effort" data packet by setting up the integer range over which the die length and the random number of slot time in the collision-avoidance period Tcw are distributed according to the class of data transmitted.
[0050] Drawing 1 explains the 1st operation gestalt of the wireless packet priority-control approach by this invention.
[0051] This 1st operation gestalt is Tcw [in / it is an access-control method based on DCF in the wireless medium between AP and STA, and / back-off control]. It is distinguishing between the unit time amount of one slot of AP or STA, and setting die length as it beforehand, according to the priority of data, and is the method which performs the priority control in within the limits of a best effort type taking advantage of the features of fairness serious consideration of a contention access control.
[0052] In step S7 of the flow chart of drawing 2 mentioned above, when recognized as the excellent effort mold, priority attachment of Tcw is performed. Here, it distinguishs between base unit time amount, without changing the range of a random number, and slot time is changed.
[0053] As shown in drawing 1 , priority is given because give slot time TA of a short period to high packet transmission (for example, the AP side) of priority and priority gives the slot time (TBxm=0-10) of a long period to low packet transmission (for example, the STA side), the collision-avoidance period of the terminal which is going to transmit the high packet of priority is shortened, and the probability which can be transmitted first is made high.
[0054] In addition, in order to perform the approach of weighting whether to transmit the high data packet of priority with the priority of how much to the low data packet of priority, by the width of face of slot time, the relation of both slot time does not need to be an integral multiple. Therefore, a setup of the priority of a transmitting probability according to priority can be performed with a degree of freedom.
[0055] The example of operation at the time of performing the priority control in the 1st operation gestalt is explained. Drawing 1 is an example about the control at the time of taking a time-axis along an axis of abscissa, actuation of the communication link in each terminal being shown on an axis of ordinate, the data packet transmission to AP from STA1 and ACK reception being completed, a packet including priority reaching AP from a cable network side, and the low data packet of the priority of the waiting for transmission existing in STA2 further.
[0056] 1 slot time over the STA2 side by which priority sets to TA 1 slot time over AP made high, and is made low [priority] which serves as the description with this operation gestalt is set to TB.
[0057] First, after STA1 receives the ACK packet which is the check over transmission to AP, AP and STA2 with the packet of the waiting for transmission go into the carrier sense of the period DIFS (TD) defined beforehand.
[0058] After this DIFS period (TD) checks that a wireless medium is a no-transmission state, AP and STA2 start the back-off control used for the collision avoidance of data packet transmission, respectively. Under the present circumstances, when the priority of the data packet which AP is going to transmit considers as a high thing, the relation of die-length TB of the slot time given to the die length TA and STA2 of the slot time given to AP is TA<TB. — (1) (TB=kTA k it becomes rate) of the priority of the data packet transmission from which priority differs. In addition, at the example shown in drawing 1 , it is k= 1.5. — It is referred to as (2). It is on this relation, and out of uniform distribution with the equal integer range (referred to as 0-10 in the example in drawing 1), a random number is subtracted and each slot time is applied to the lengthened random-number value.
[0059] "6" is assigned to "7" and **STA2 by **AP in the example shown in drawing 1 . However, the relation of Tcw of both, who saw from time amount length from (2) types which the ratio of the packet priority of AP and STA2 mentioned above although the collision-avoidance period of AP was 7 slot time and the collision-avoidance period of STA2 was 6 slot time, since it

was 1.5 times, is 7xTA<8xTB=8x1.5xTA. — (3)
It becomes. Thereby, high AP of priority performs data transmission (P1) ahead of STA2. After the communication link, after AP receives ACK (Pa) to own transmission from STA1, carrier sense of a DIFS period (TD) is carried out further.
[0060] Here, if it is a no-transmission state, AP and STA2 in which the packet of the waiting for transmission exists again will start back-off control. At this time, the collision-avoidance period of **STA2 turns into 3 slot time which deducted 3 slot time which has passed since 6 slot time. Moreover, since the priority of the data packet of AP was high, the die length of slot time should be set to TA, and the random number should newly be subtracted, for example, "4" should be assigned, and the collision-avoidance period should turn into 4 slot time. Consequently, the relation of Tcw of **AP and **STA2 both is 4xTA<3xTB=3x1.5xTA from (1) and (2) types. — (4)

It becomes the relation to say, the collision-avoidance period of AP becomes shorter than STA2 again, and AP performs data transmission (P1) previously.
[0061] And after carrying out carrier sense of a DIFS period (TD), in the next back-off control, the Request to Send of the high packet of the 3rd priority happens to **AP, and slot time length serves as TA. If the random number which AP in this back-off control subtracted is "5", the relation of Tcw of AP and STA2 is 5xTA>2xTB=2x1.5xTA from (1) and (2) types. — (5)
A next door and the collision-avoidance period of STA2 become short, and the transmission of a data packet P2 of them is attained from AP.
[0062] As mentioned above, since, as for the priority-control approach by this operation gestalt, the slot time in a collision-avoidance period is short set up from the one where the priority of a data packet is higher, even if a large random number is given to the one where the priority of a data packet is higher, a random collision-avoidance period (Contention Window:Tcw) becomes [the probability which becomes short] high, and priority can transmit a high data packet first as a result. It enables this to perform a priority control, with the features of a contention access control not lost.
[0063] Next, drawing 3 explains the 2nd operation gestalt of the wireless packet priority-control approach by this invention.
[0064] With the 1st operation gestalt mentioned above, 1 slot time is changed without changing the range of a random number, the collision-avoidance period Tcw is changed, and although it was the approach of performing priority attachment to a packet, in this operation gestalt, the digestive approach of the given collision-avoidance period Tcw is changed, without changing the range and 1 slot time of a random number.
[0065] In back-off control, in case the terminal with which this operation gestalt is going to transmit the low data packet of priority in a collision-avoidance period Tcw setup checks that the wireless medium is not used, it is the control approach which inserts the waiting slot time which stands by in a 1-time excess for every number slot time in addition to the slot time originally assigned. The probability that the high data packet of priority can be first transmitted as this result is made high.
[0066] Therefore, although it is not concerned with the height of priority but the collision-avoidance period Tcw is set up at random in the phase which subtracts a random number, since the digestive rate of the collision-avoidance period Tcw becomes early compared with the low thing of priority, the latency time of the terminal which is going to transmit the packet with high priority to transmission decreases, and the probability which the terminal which is going to transmit the high packet of priority as a result can transmit first becomes high.
[0067] By this approach, a setup of the priority of the data packet transmitting probability for priority to differ is performed by the approach of digestion of the collision-avoidance period in back-off control, and it can carry out, without changing the width of face of slot time, and the generating range of a random number, Moreover, it is not taking collectively the excessive indispensable latency time produced at the time of the low priority packet transmission at the time of a high priority packet absence between fixed range, but considering as N time at number slot time, and it is the features that the effect can be lessened.
[0068] Drawing 3 takes a time-axis along an axis of abscissa, and actuation of the

communication link in each terminal is shown on the axis of ordinate. First, a data packet is transmitted to AP from STA1, and reception of ACK (Pa) to the transmission is completed. And it is in the condition that the low data packet of the priority which a packet including priority should reach AP from a cable network side, and should transmit to STA2 further exists.
[0069] First, a series of data transmitting procedures from STA1 to AP are completed, and it operates after progress of DIFS (TD) like drawing 1 mentioned above until AP and STA2 started back-off control, respectively.
[0070] And as for both STAs2 that are going to transmit AP which is going to transmit the high data of priority, and the low data of priority, one value is given from the random number to integers 0-10.
[0071] For example, one criteria slot time shall not be based on priority, but shall consist of the same time amount, and, in the case of drawing 3 , 3 slot time according [**AP] to random-number"3" and **STA2 shall be 7 slot time by random-number"7." At this time, in 7 slot time given to STA2, every 2 slot time, the waiting slot time for 1 time is set as a pan by one so that it may be. Therefore, the collision-avoidance period Tcw turns into 11 slot time and equivalent time amount in fact.
[0072] And although both reduce the collision-avoidance period Tcw during the back-off control period, since AP and STA2 have set up with 1.5 the ratio of the priority of the data packet which exists in AP and STA2 both, AP which has the high data packet of priority digests the collision-avoidance period Tcw early 1.5 times compared with STA2.
[0073] For this reason, only a part for 2 slot time among the collision-avoidance time amount set up by the random numbers in fact since 1 slot time was added to 2 slot time in STA2 while AP transmits data and a part for 3 slot time is digested is digested, but, in the remaining parts, surroundings and ** collision-avoidance period Tcw becomes next back-off control with a part for 5 slot time (in order that three waiting slot time may enter in fact, it is equivalent to 8 slot time).
[0074] next, AP transmits the 1st data packet, after progress of DIFS (TD), when the high data packet of priority reaches AP from a cable network side, AP lengthens one value out of the random-number range 0-10 again, and "6" gives — having — ** — the following collision-avoidance time amount Tcw turns into 8 slot time. Result [Tcw of STA2 by which the 1st transmission was postponed is 5 slot time and it compared 8 slot time of this and AP] (6x slot time / 1.5) <(5x slot time) — (6)
Also in a next door and the 2nd back-off control, the direction of the collision-avoidance period of AP becomes short, and it will precede and transmit.
[0075] And when AP transmits the 2nd data packet, since 6 slot time is digested by AP, by STA2, 4 slot time is digested and, as for 5 slot time of STA2, **1 slot time (in fact, since 1 time of waiting slot time is contained, it is equivalent to 2 slot time) remains.
[0076] Next, after progress of DIFS (TD), rather than STA, when a data packet with still higher priority reaches AP from a cable network side, AP subtracts a random number out of the random-number range 0-10 to it, and obtains random-number value"3" to it. Thereby, Tcw of **AP serves as 3 slot time.
[0077] By the way, in the 3rd transmission, the value of Tcw of low STA2 of priority is 1 slot time (it is 2 slot time containing one waiting slot time in fact), and they are AP, and STA2 and Tcw. (3x slot time / 1.5) > (1x slot time) — (7)
The data packet of STA2 is transmitted at last by the next door and the 3rd time of these. In this transmission, 2 slot time is digested and the collision-avoidance period of AP turns into 1 slot time.
[0078] Furthermore, in the 4th transmission, when the data packet which should transmit to STA2 occurs, STA2 subtracts a random number out of the random-number range 0-10, and obtains random-number value"4." Thereby, Tcw of **STA2 serves as 4 slot time (in practice, in order that two waiting slot time may enter, it is equivalent to 6 slot time).
[0079] Since waiting slot time is given once to the collision-avoidance period with the lower priority of a data packet to two slots according to these above operation gestalten, Priority compares with a high data packet. The low data packet of priority Even if the same random-

number value is given, it sees and the slot time as upper Tcw is the same, the time amount actually digested becomes long 1.5 times, and the probability to transmit previously a data packet with priority high as a result becomes high.

[0080] Next, drawing 4 explains the 3rd operation gestalt of the wireless packet priority-control approach by this invention.

[0081] This operation gestalt is the approach of performing weighting to the range of a random number, without changing the digestive approach of modification of slot time or a collision-avoidance period like the 1st and 2nd operation gestalt mentioned above, and giving priority to the transmitting probability of a data packet by changing the generating range of a random number, collision avoidance is carried out and it is transmitted.

[0082] A short collision-avoidance period may be assigned to the terminal which is already going to transmit the low packet of priority from the random-number value lengthened first by not classifying the perfect random-number range according to the priority of data, and making the part which the range of each other overlaps from this operation gestalt.

[0083] As opposed to the collision-avoidance period Tcw being shortened only for the part which stood by transmission by the conventional approach instead, with this operation gestalt As opposed to the terminal which is going to transmit the low data packet of priority a collision-avoidance period It considered as the approach of adding the slot time equivalent to the minimum value of a random-number value in the collision-avoidance period of the 2nd henceforth fixed so that it might not become below the value that imposed slot time on the minimum value in the range of a random number always.

[0084] Concretely, as range distribution of this random number is shown in drawing 4 , in a collision-avoidance period Tcw setup, the terminal (for example, AP) which the terminal (for example, STA2) which is going to transmit the low data packet of priority tends to set to 3-10 the range of the random number given when making 3 slot time into fixed time amount, and is going to transmit the high data packet of priority sets up the random-number range given with 0-7. The probability which the terminal which is going to transmit the high data packet of priority can transmit first by this setup becomes high.

[0085] In this drawing 4 , the actuation to the condition that STA1 ends transmission of data, the high data packet of priority exists in AP, and the low data packet of priority exists in STA2 is the same as that of drawing 1 and drawing 3 which were mentioned above.

[0086] The actuation which performs the priority control of this operation gestalt sets up the random-number range of AP which is going to transmit the high data packet of priority with 0-7, and subtracts a random number from the inside. Moreover, the random-number range of STA2 which is going to transmit the low data packet of priority considers as the integer to 3-10, and subtracts a random number. By such setup, even if STA2 can give the minimum value, it becomes 3 slot time, and substantially, 3 slot time by the side of the head of a collision-avoidance period is the same as what is always being fixed.

[0087] Thus, in the low data packet side of priority, the fixed value of immobilization will surely be taken. In drawing 4 , if "4" is given to AP from the random-number range and "7" is given to STA2 from the random-number range, **AP will serve as 4 slot time and **STA2 will serve as 7 slot time.

[0088] And when AP transmits the 1st data and the high data packet of priority reaches AP from a cable network side again, again, a random number is subtracted out of the random-number range 0-7, for example, "3" is given to the collision-avoidance period of **AP.

[0089] Moreover, in the collision-avoidance period Tcw, STA2 postponed in the 1st transmission digests only 4 slot time, and serves as remainder 3 slot time. However, among this 4 slot time, in back-off control, since it is the period for which it must wait, a part for 3 slot time is not counted as digested slot time. For this reason, the digested number of slots in the last back-off control becomes a part for 1 slot time, and a part for the remaining 3 slot time is carried over as time amount for which it must wait.

[0090] In the 2nd transmission, the collision-avoidance period Tcw in **STA2 turns into 8 slot time by which 3 slot time for which it must wait was added to 3 slot time which was not digested at the time of the 1st transmission. Moreover, in AP, a random number is subtracted out of the

random-number range 0-7, for example, "3" is given. Thereby, also in the 2nd transmission of a data packet, the collision-avoidance period Tcw of AP becomes shorter than the collision-avoidance period Tcw in STA2, and transmission of AP is performed preferentially.

[0091] And the 2nd data packet is transmitted, after progress of DIFS (TD), when the high data packet of priority reaches AP from a cable network again, AP subtracts a random number out of the random-number range 0-7, "7" is given, and the collision-avoidance period Tcw of **AP turns into 7 slot time.

[0092] Moreover, as for the collision-avoidance period Tcw of **STA2, in the 2nd back-off control, although 3 slot time is digested and 3 slot time turns into residual time, the collision-avoidance period Tcw of this **STA2 turns into 8 slot time which added 3 slot time which turns into said residual time at 3 slot time which surely turns into the latency time.

[0093] Therefore, since the collision-avoidance period Tcw of STA2 turns into [the collision-avoidance period Tcw of AP] 8 slot time by 7 slot time, STA2 of time amount is shorter and data can be transmitted.

[0094] It is the approach of making it the probability for a data packet with high priority to be transmitted previously become high, by the priority-control approach of this 3rd operation gestalt preparing beforehand the waiting slot time which surely turns into the latency time in a head side fixed at the collision-avoidance period Tcw given to the terminal which is going to transmit the low data packet of the priority of a data packet, as explained above, and adding the slot time which was not digested by the last time except waiting slot time.

[0095] The above explanation described the case where the high data packet of priority was mainly transmitted to STA from AP, with the 1st thru/or 3rd operation gestalt. About a setup of the priority of the data from AP to STA, it is manageable unitary by AP. A setup of the priority of the data generated in each STA is carrying out in the procedure shown below, and becomes controllable as a system.

[0096] First, in order to enforce each priority-control approach explained in drawing 1 , drawing 3 , and drawing 4 , all STAs need to notify the priority of the data packet, before transmitting a data packet to AP, and need to obtain the authorization to performing data packet transmission by the priority from AP further.

[0097] In advance of data packet transmission, STA1 and STA2 in drawing 1 , drawing 3 , and drawing 4 transmit to AP by making into a communication packet priority information considered to be the need in the data packet transmission.

[0098] First, AP which received the communication packet including priority information from STA1 and STA2 determines the priority permitted to STA1 and STA2 in consideration of the priority level demanded from whole traffic and whole STA, and transmits this as a communication packet by return to each STA.

[0099] And STA1 and STA2 perform a priority control by performing weighting in the generating range of a random number according to the priority information on the communication packet from this AP by the priority-control approach of the 3rd operation gestalt which shows the digestive approach of slot time in drawing 4 by the priority-control approach of the 2nd operation gestalt which shows the die length of slot time in drawing 3 by the priority-control approach of the 1st operation gestalt shown in drawing 1 .

[0100] By performing a setup of the priority by the communication packet between such AP-STA in advance of activation of a priority control, system control can be carried out so that each STA may acquire freely high priority and may not perform data transmission.

[0101] Thus, as for the priority-control approach of this invention, the priority of a data packet uses that the probability for the higher one to become [the probability for the die length of Tcw to become short] high, and to transmit previously a data packet with priority high as a result becomes high. It enables this to perform a priority control, with the features of a contention access control not lost.

[0102]

[Effect of the invention] the priority control by according to this invention, treating not all data packets similarly as a best effort type, but performing priority attachment, as explained in full detail above — "a best effort type" — it comes to be able to perform preferential packet

transmission For this reason, although the demand to QA is not carried out, the wireless packet priority-control approach whose flexible correspondence to the user who wants to receive preferential treatment of service from a best effort type is attained can be offered.

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TECHNICAL FIELD

[Field of the invention] This invention relates to the wireless packet priority-control approach which makes possible the priority control which started wireless LAN, especially distinguished the packet in within the limits of a best effort type.

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PRIOR ART

[Description of the Prior Art] Generally, as a wireless access method, the access method in the wireless LAN system specified in IEEE 802 Committee is typical.
[0003] This convention is described by the detail at "IEEE802.11, Draft Standard for Wireless LAN Medium AccessControl(MAC) and Physical Layer(PHY) Specification, P802.11D 8.0, 1 May 1998." Hereafter, this convention is called as "IEEE802.11 specification" and explained.
[0004] The access method of a MAC layer is described in "IEEE802.11 specification."
[0005] Here, about the contention access control, while two or more STAs (radio station) of a base transceiver station (AP) and a subordinate carry out carrier sense so that the collision of a packet may not arise, DCF (Distributed Coordination Function decentralized control procedure) using the CSMA/CA (Carrier Sense Multiple Access Collision Avoidance) method which transmits data is used.
[0006] Drawing 5 shows the communication link actuation to the time amount in DCF which "IEEE802.11 specification" is shown. In this drawing, two radio stations (STA is called hereafter) which carry out wireless packet communication are shown by making an axis of abscissa into the passage of time, for example, the actuation after data transmission of STA1 is completed is shown.
[0007] Here, in "IEEE802.11 specification", IFS (Inter Frame Space) is the time amount of carrier sense for AP and STA to get to know the condition of a wireless medium, and four kinds such as SIFS (Short IFS), PIFS (PCF(Point Coordination Function) IFS), DIFS (DistributedIFS), and EIFS (ExtendedIFS) are specified in the short order of time amount, i.e., the high order of the priority of access. In addition, DIFS used as the carrier sense time amount in the case of transmitting a data packet signal relates to this invention.
[0008] Here, data transmission is performed from STA1 to AP at time of day T, and it is assumed that AP and STA2 suited the transmitting standby condition.
[0009] First, STA1 transmits data P1 to AP, and after receiving from AP the ACK packet (Pa) which answers reception of that, AP and STA2 stand by until they carry out (TD) progress between DIFS(s).
[0010] And the collision-avoidance period (Contention Window:Tcw) used as random time amount is given to each of AP and STA2. This collision-avoidance period is searched for by the multiplication of base unit time amount and a random number so that it may mention later.
[0011] AP and STA which have the data packet which should transmit as the Ruhr in [whole] all STAs containing AP subtract the random number which the integer of a certain range distributes uniformly in the decision of this collision-avoidance period. And the base unit time amount (slot time) of a collision-avoidance period is spent on the acquired random-number value, and the collision-avoidance period Tcw comes.
[0012] Transmission is started if a wireless medium does not become a busy after this period progress. In drawing 6 , 1 slot time (the number of 1 slots) is illustrated with one coma, in this example, the collision-avoidance period of 4 coma x slot time is given to AP, and the collision-avoidance period of 7 coma x slot time is given to STA2. Also in the drawing of this invention explained henceforth, it is the same. Since it is short compared with STA2, AP becomes preferential and the collision-avoidance period Tcw of given AP transmits data to STA1 from AP

after this collision-avoidance period (4 slot time) progress. Transmission of STA2 at this time is postponed.
[0013] Furthermore, the ACK (Pa) transmission to AP is ended, and further, after DIFS(TD) period progress, since Tcw in the back off of STA2 becomes the shortest shortly, STA2 becomes data ready-for-sending ability. The collision is ensuring little packet transmission to the bottom of a race condition by the above sequences.
[0014] The RANDOMU back off used as the latency time after the DIFS progress mentioned above is actuation for reducing the collision between STAs which are going to transmit to coincidence probable, and the latency time in this back off hits at a collision-avoidance period.
[0015] In order for two or more STAs which have data which should be transmitted to prevent transmitting to coincidence by carrying out standby of a different collision-avoidance period acquired with the random number, respectively before data transmission, they become possible [preventing the collision of a data packet].
[0016] Drawing 6 is drawing for explaining the another conventional approach.
[0017] In this conventional example, although are concerned, there is nothing in the importance of data and the collision-avoidance period Tcw was given at random with the conventional technique mentioned above, priority attachment is performed to the dis length of the collision-avoidance period Tcw, and the priority control according to the priority of a data packet is performed because the random number which STA with the data packet which transmits subtracts changes that range not according to uniform distribution but according to the priority of a packet which should be transmitted.
[0018] This example shows what communicates by AP and the radio station (STA1, STA2) of two games sharing the same frequency, and AP has the data packet P2 over which priority is un-given to STA2 in the packet data P1 with which priority is given to transmission compared with AP after packet transmitting termination of STA1, and has these Requests to Send. 5(fixed value)+0-5 [0-5 are assigned to this data packet P1 for slot time and / slot time / **********], i.e., the slot time of 5-10 is in a data packet P2. In this case, since a data packet P2 has priority lower than P1, 5 slot time surely turns into the latency time.
[0019] After STA1 receives the ACK packet to own data transmission, after both AP, STA1, and STA2 pass between DIFS(s) (TD), a procedure moves from them to the back off. Under the present circumstances, in determining the collision-avoidance period Tcw which is a period of the back off, each of STA and AP subtracts a random number, but weighting is made according to the priority of the packet of data which should transmit the integer range over which this random number is distributed.
[0020] By **, since priority is lower than a data packet P1, specifically, for example, "6" slot time is given for a data packet P2 from between 5-10 as the packet transmitting latency time. ** The waiting slot time in the last back-off control is "4", and this is smaller than "5" of the slot time which must be made into the latency time. For this reason, the waiting slot time in this back off is again set to "6." ** Set, the waiting slot time in the last back-off control is "3", and this is smaller than "5" of the slot time which must be made into the latency time. For this reason, the waiting slot time in this back off is again set to "6." ** "4" has been obtained from between transmission of a data packet P1 to 0-5. ** Value "3" has been obtained from between 0-5 as waiting slot time for transmission of a data packet P1.
[0021] In the case of drawing 6 [such], the priority of transmission is determined with reference to the header information in the head of the data which should be transmitted etc. And in order that AP may transmit the high packet of priority and 0-5, and STA2 may transmit the packet with low priority as for the range of a random number, the range of a random number is set up with 5-10. Thus, in order that STA2 which is going to transmit the low data packet of priority may wait [in / slot time / 5 / in the minimum / ** back-off control], the data packet of AP will surely be transmitted in advance of STA2.
[0022] As mentioned above, the priority control within a contention access-control DCF period becomes possible by changing the range of a random number according to the priority of a data packet.

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EFFECT OF THE INVENTION

[Effect of the Invention] the priority control by according to this invention, treating not all data packets similarly as a best effort type, but performing priority attachment, as explained in full detail above -- "a best effort type" -- it comes to be able to perform preferential packet transmission For this reason, although the demand to QA is not carried out, the wireless packet priority-control approach whose flexible correspondence to the user who wants to receive preferential treatment of service from a best effort type is attained can be offered.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The priority control set as the object of this invention has a typical method using the priority class specified in IEEE 802 Committee. This convention is described by the detail at "IEEE P802.1D Annex H, Design Consideration for Traffic Class Expediting and Dynamic Multicast Filtering, P802.1D, 25 May 1998." Hereafter, this convention is called "IEEE P802.1D specification."

[0024] Although the class which asks for "a positive guarantee" of qualities of service [class / in "IEEE P802.1D specification" / priority], such as a guarantee of the maximum time delay or a guarantee of bandwidth, here, and a guarantee are not needed, they are divided roughly into a "preferential BESUTOETO mold" class with priority higher than a best effort type (excellent effort mold). The priority control in this invention is the type of the latter which performs control according to the priority in the inside of a best effort type.

[0025] Here, in DCF in "IEEE 802.11 specification", the period "Contention Window" required in order to make a contention access control without a collision possible by applying the integer given to the number of slots which is the fixed-length conventional time with the generated random number is set up.

[0026] By the way, in order to perform the priority control according to that priority to a data packet with priority, in the wireless access method which gave semantics, priority attachment is needed but for transmitting spacing of data to a setup of Tcw, and in the decentralized control DCF based on CSMA/CA, since it sets it as the main purposes to give "a fair access opportunity", this priority attachment is not performed.

[0027] That is, since the die length of the collision-avoidance period Tcw is set up taking advantage of the random nature of a random number which made it generate from the integer which distributes uniformly the slot time which is the conventional time of the back off by considering as fixed time, the way things stand, control to the priority of a packet cannot be performed.

[0028] Moreover, there is a method of changing the integer range over which it is distributed according to the priority of a data packet to the random number subtracted in the case of a collision-avoidance period Tcw setup as the priority-control approach based on DCF as which the former which was mentioned above is proposed.

[0029] However, it must wait for 5 slot time of the collision-avoidance period in the range where the low data packet of priority is prepared for the high data packets of priority after DIFS termination even when the high data packet of priority does not exist, for example, drawing 6 , by this approach. The unnecessary latency time will exist by this and there is a problem of causing decline in frequency use effectiveness.

[0030] Furthermore, in a setup of the non-competing access period by the centralized control of AP, to QA of a priority control and a communication link being attained, by DCF which offers the contention access period by distributed cooperative control, even if it can perform a perfect priority control, carrying out to a guarantee of communication link quality has the trouble that it is difficult and the features of each control approach of PCF and DCF cannot be utilized thoroughly for this reason.

[0031] Then, this invention aims at offering the wireless packet priority-control approach in

which the features of the "fairness of access" which a contention access control has which solve the trouble that the priority control which followed the priority of data by performing a setup of the collision-avoidance period Tcw based on the random random number is not made, and are not in the priority control within the DCF period by which the conventional proposal is made were made to reflect more.

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MEANS

[Means for Solving the Problem] The base transceiver station connected to a cable network in order that this invention may attain the above-mentioned purpose, Are in this base transceiver station and a dependency, and consist of two or more radio stations which perform wireless packet communication, and said base transceiver station and the radio station of said large number use a common radio channel, and the propriety of transmission is mutually judged independently at the time of a communication link. The collision of a packet is avoided. In the wireless packet priority-control approach in the wireless packet communication which performs the contention access control based on CSMA/CA (Carrier Sense Multiple Access Collision Avoidance) which transmits a wireless packet If a data packet including the priority information which shows the height of the priority in the inside of the best effort type which should perform transmitting processing within the contention access-control section is received, said base transceiver station and said radio station Memorize, while acquiring this priority information, and before the data transmission by said contention access control The wireless packet priority-control approach that a data packet with the higher priority information on said memorized data packet sets up said slot time short is offered in a setup of the collision-avoidance period (Contention Window) which consists of a multiple of base unit time amount (slot time).
[0033] Even if a large random number is given to the one where the priority of a data packet is higher by such wireless packet priority-control approach by setting the one where the priority of data is higher as short time amount for slot time, as for the die length of a random collision-avoidance period (Contention Window:Tcw), the probability which becomes short becomes high, and a data packet with priority high as a result is transmitted previously.
[0034]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail with reference to a drawing. First, with reference to the flow chart shown in drawing 2 , the concept of the wireless packet priority-control approach by this invention is explained. The communication link of this invention consists of a base transceiver station (AP) connected to a cable network, and a radio station (STA) which is in this AP and dependency and carries out wireless packet communication, and AP and all STAs are using the common radio channel.
[0035] Under the present circumstances, the period which performs the contention access control based on the CSMA/CA (Carrier Sense Multiple AccessCollision Avoidance) method of judging the propriety of transmission autonomously mutually, permitting the collision of a packet, and transmitting a wireless packet, and the non-competing access control by AP polling is repeated a fixed period, and wireless packet communication is performed by directing by the control information which AP reports that this period and period are.
[0036] First, AP will check the priority of a data packet, if a data packet including the priority information on data that it arrived from the cable network side is received (step S1) (step S2). A data packet is inserted in the queue corresponding to the priority checked here (step S3). Here, it judges whether it is the data packet which asks for QA (step S4), and if it is the data packet which asks for QA by this decision (Yes), it shall be a QA mold (a band guarantee and time delay guarantee) (step S5), and will transmit to the wireless terminal STA by centralized control PCF (step S6).

[0037] On the other hand, in not being the data packet which asks for QA, it judges whether it is the packet (excellent effort mold) which should transmit more preferentially than (No) and a best effort type (step S7).
[0038] By this decision, if it is not the packet which should transmit more preferentially than a best effort type, it will be recognized as what is (No) and a best effort type (step S8), and a random collision-avoidance period (Contention Window:Tcw) will be given as usual to each of AP and STA2. Let this collision-avoidance period be the collision-avoidance period Tcw over the base unit time amount (slot time) in the random-number value and collision-avoidance period which were lengthened from a certain range.
[0039] And it judges whether a radio frequency is intact after progress of a DIFS (TD) period (step S9), and if the radio frequency is intact (Yes), as soon as the given collision-avoidance period will become zero (step S10), it transmits (step S11). Moreover, in decision of said step S7, when it is the packet which should transmit preferentially rather than a best effort type, it recognizes as (Yes, i.e., an excellent effort mold) (step S12).
[0040] Tcw which is explained with the operation gestalt mentioned later in this excellent effort mold By setting up die length short, it sets up so that the probability for random collision-avoidance time amount to become short may become high by the approach of performing priority attachment by the back-off control period mentioned later (step S13).
[0041] And it judges whether a radio frequency is intact after progress of a DIFS (TD) period (step S14), and if the radio frequency is intact (Yes), as soon as the given collision-avoidance period will become zero (step S15), it transmits (step S16). If a data packet including the priority information which shows the permission transfer delay time amount and the necessary minimum bandwidth of the data with which AP specifically arrived from the cable network side is received, a data packet with such priority is transmitted to the purpose terminal in the PCF period which is a non-competing access-control period, and when a data packet including the other priority information is received, it will transmit to the purpose terminal in a contention access-control period. Here, if a data packet including the priority information which shows the height of the priority within the best effort type which should perform transmitting processing within the contention access-control section is received, AP will be memorized while it acquires said priority information.
[0042] Furthermore, if the wireless circuit is vacant before transmitting the data based on a contention access control, a random number will be subtracted, and the probability which the high packet of priority can transmit to order first by shortening the die length of the slot time from the high class of priority is made high in a setup of the collision-avoidance period Tcw of standing by only the value.
[0043] Furthermore, in case the terminal which is going to transmit the low data packet of priority to a setup of the collision-avoidance period Tcw of DCF control in a collision-avoidance period Tcw setup of a contention access control as the 2nd method of performing priority attachment performs carrier sense of the slot time basis in back-off control, originally it inserts the latency time (waiting slot) of the slot time basis still more nearly excessive N times for every number slot other than the assigned slot time.
[0044] The probability that the high packet of priority can be first transmitted for the time amount from which the collision-avoidance period Tcw of the terminal which is going to transmit the low data of priority by this serves as zero as a result of [its] lateness is made high.
[0045] Moreover, the part which the range overlaps mutually by the priority of a data packet in the generating range of the random number which each STA subtracts is left and determined as an approach of performing priority attachment, in a setup of the collision-avoidance period Tcw of DCF control in the case of a collision-avoidance period setup by the contention access control, and the random number assigned from each integer range is determined.
[0046] Furthermore, it considers as a collision-avoidance period by multiplying the slot time which is not concerned with priority but has a fixed value in the subtracted random number. And the terminal which is going to transmit the low data packet of priority The time amount of the value which imposed slot time on the minimum value in the range of the subtracted random number is set to ** back-off control. Surely Waiting, When other STAs transmit data during a

collision-avoidance period, the data transmission from the end of a local is interrupted. When it waits for the collision-avoidance period of a next contention access-control period exceeding the time amount for which it must wait in ** back-off control, the probability that the high packet of priority can be transmitted first is made high by reducing only the part of the number of slot time for which it exceeded and waited.

[0047] Moreover, when there is a data packet Request to Send of the going-up direction from STA to AP, in advance of transmission of a priority data packet, STA transmits the priority of the packet which transmits to AP as a communication packet. And AP which received the communication packet determines the die length of the basic time-basis time amount of the collision-avoidance period permitted to this STA, and transmits a connection packet to STA by return [time amount / the / base unit].

[0048] Moreover, when there is a data packet Request to Send of the going-up direction from STA to AP, in advance of transmission of a priority data packet, STA transmits the priority of the packet which transmits to AP as a communication packet. And AP which received this communication packet determines insertion spacing of the waiting slot time in Tcw permitted to this STA corresponding to the priority of a packet, or the generating range of a random number, turns up the setting information on Tcw, and transmits by the communication packet to STA.

[0049] As mentioned above, the priority control of the data packet of an "excellent effort mold" is realizable to a "best-effort" data packet by setting up the integer range over which the die length and the random number of slot time in the collision-avoidance period Tcw are distributed according to the class of data transmitted.

[0050] Drawing 1 explains the 1st operation gestalt of the wireless packet priority-control approach by this invention.

[0051] This 1st operation gestalt is Tcw [in / it is an access-control method based on DCF in the wireless medium between AP and STA, and / back-off control]. It is distinguishing between the unit time amount of one slot of AP or STA, and setting die length as it beforehand, according to the priority of data, and is the method which performs the priority control in within the limits of a best effort type taking advantage of the features of fairness serious consideration of a contention access control.

[0052] In step S7 of the flow chart of drawing 2 mentioned above, when recognized as the excellent effort mold, priority attachment of Tcw is performed. Here, it distinguishs between base unit time amount, without changing the range of a random number, and slot time is changed.

[0053] As shown in drawing 1 , priority is given because give slot time TA of a short period to high packet transmission (for example, the AP side) of priority and priority gives the slot time (TBxrn=0-10) of a long period to low packet transmission (for example, the STA side), the collision-avoidance period of the terminal which is going to transmit the high packet of priority is shortened, and the probability which can be transmitted first is made high.

[0054] In addition, in order to perform the approach of weighting whether to transmit the high data packet of priority with the priority of how much to the low data packet of priority, by the width of face of slot time, the relation of both slot time does not need to be an integral multiple. Therefore, a setup of the priority of a transmitting probability according to priority can be performed with a degree of freedom.

[0055] The example of operation at the time of performing the priority control in the 1st operation gestalt is explained. Drawing 1 is an example about the control at the time of taking a time-axis along an axis of abscissa, actuation of the communication link in each terminal being shown on an axis of ordinate, the data packet transmission to AP from STA1 and ACK reception being completed, a packet including priority reaching AP from a cable network side, and the low data packet of the priority of the waiting for transmission existing in STA2 further.

[0056] 1 slot time over the STA2 side by which priority sets to TA 1 slot time over AP made high, and is made low [priority] which serves as the description with this operation gestalt is set to TB.

[0057] First, after STA1 receives the ACK packet which is the check over transmission to AP, AP and STA2 with the packet of the waiting for transmission go into the carrier sense of the period DIFS (TD) defined beforehand.

[0058] After this DIFS period (TD) checks that a wireless medium is a no-transmission state, AP and STA2 start the back-off control used for the collision avoidance of data packet transmission, respectively. Under the present circumstances, when the priority of the data packet which AP is going to transmit considers as a high thing, the relation of die-length TB of the slot time given to the die length TA and STA2 of the slot time given to AP is TA<TB. — (1) (TB=kxTA k: It becomes rate) of the priority of the data packet transmission from which priority differs. In addition, at the example shown in drawing 1 , it is k= 1.5. — It is referred to as (2). It is on this relation, and out of uniform distribution with the equal integer range (referred to as 0-10 in the example in drawing 1), a random number is subtracted and each slot time is applied to the lengthened random-number value.

[0059] "6" is assigned to "7" and **STA2 by **AP in the example shown in drawing 1 . However, the relation of Tcw of both, who saw from time amount length from (2) types which the ratio of the packet priority of AP and STA2 mentioned above although the collision-avoidance period of AP was 7 slot time and the collision-avoidance period of STA2 was 6 slot time, since it was 1.5 times, is 7xTA<6xTB=6x1.5xTA. — (3)

It becomes. Thereby, high AP of priority performs data transmission (P1) ahead of STA2. After the communication link, after AP receives ACK (Pa) to own transmission from STA1, carrier sense of a DIFS period (TD) is carried out further.

[0060] Here, if it is a no-transmission state, AP and STA2 in which the packet of the waiting for transmission exists again will start back-off control. At this time, the collision-avoidance period of **STA2 turns into 3 slot time which deducted 3 slot time which has passed since 6 slot time. Moreover, since the priority of the data packet of AP was high, the die length of slot time should be set to TA, and the random number should newly be subtracted, for example, "4" should be assigned, and the collision-avoidance period should turn into 4 slot time. Consequently, the relation of Tcw of **AP and **STA2 both is 4xTA<3xTB=3x1.5xTA from (1) and (2) types. — (4)

It becomes the relation to say, the collision-avoidance period of AP becomes shorter than STA2 again, and AP performs data transmission (P1) previously.

[0061] And after carrying out carrier sense of a DIFS period (TD), in the next back-off control, the Request to Send of the high packet of the 3rd priority happens to **AP, and slot time length serves as TA. If the random number which AP in this back-off control subtracted is "5", the relation of Tcw of AP and STA2 is 5xTA>2xTB=2x1.5xTA from (1) and (2) types. — (5)

A next door and the collision-avoidance period of STA2 become short, and the transmission of a data packet P2 of them is attained from AP.

[0062] As mentioned above, since, as for the priority-control approach by this operation gestalt, the slot time in a collision-avoidance period is short set up from the one where the priority of a data packet is higher, even if a large random number is given to the one where the priority of a data packet is higher, a random collision-avoidance period (Contention Window:Tcw) becomes [the probability which becomes short] high, and priority can transmit a high data packet first as a result. It enables this to perform a priority control, with the features of a contention access control not lost.

[0063] Next, drawing 3 explains the 2nd operation gestalt of the wireless packet priority-control approach by this invention.

[0064] With the 1st operation gestalt mentioned above, 1 slot time is changed without changing the range of a random number, the collision-avoidance period Tcw is changed, and although it was the approach of performing priority attachment to a packet, in this operation gestalt, the digestive approach of the given collision-avoidance period Tcw is changed, without changing the range and 1 slot time of a random number.

[0065] In back-off control, in case the terminal with which this operation gestalt is going to transmit the low data packet of priority in a collision-avoidance period Tcw setup checks that the wireless medium is not used, it is the control approach which inserts the waiting slot time which stands by in a 1-time excess for every number slot time in addition to the slot time originally assigned. The probability that the high data packet of priority can be first transmitted as this result is made high.

[0066] Therefore, although it is not concerned with the height of priority but the collision-avoidance period Tcw is set up at random in the phase which subtracts a random number, since the digestive rate of the collision-avoidance period Tcw becomes early compared with the low thing of priority, the latency time of the terminal which is going to transmit the packet with high priority to transmission decreases, and the probability which the terminal which is going to transmit the high packet of priority as a result can transmit first becomes high.

[0067] By this approach, a setup of the priority of the data packet transmitting probability for priority to differ is performed by the approach of digestion of the collision-avoidance period in back-off control, and it can carry out, without changing the width of face of slot time, and the generating range of a random number, Moreover, it is not taking collectively the excessive indispensable latency time produced at the time of the low priority packet transmission at the time of a high priority packet absence between fixed ranges, but considering as N time at number slot time, and it is the features that the effect can be lessened.

[0068] Drawing 3 takes a time-axis along an axis of abscissa, and actuation of the communication link in each terminal is shown on the axis of ordinate. First, a data packet is transmitted to AP from STA1, and reception of ACK (Pa) to the transmission is completed. And it is in the condition that the low data packet of the priority which a packet including priority should reach AP from a cable network side, and should transmit to STA2 further exists.

[0069] First, a series of data transmitting procedures from STA1 to AP are completed, and it operates after progress of DIFS (TD) like drawing 1 mentioned above until AP and STA2 started back-off control, respectively.

[0070] And as for both STAs2 that are going to transmit AP which is going to transmit the high data of priority, and the low data of priority, one value is given from the random number to integers 0-10.

[0071] For example, one criteria slot time shall not be based on priority, but shall consist of the same time amount, and, in the case of drawing 3 , 3 slot time according [**AP] to random-number"3" and **STA2 shall be 7 slot time by random-number"7." At this time, in 7 slot time given to STA2, every 2 slot time, the waiting slot time for 1 time is set as a pan by one so that it may be. Therefore, the collision-avoidance period Tcw turns into 11 slot time and equivalent time amount in fact.

[0072] And although both reduce the collision-avoidance period Tcw during the back-off control period, since AP and STA2 have set up with 1.5 the ratio of the priority of the data packet which exists in AP and STA2 both, AP which has the high data packet of priority digests the collision-avoidance period Tcw early 1.5 times compared with STA2.

[0073] For this reason, only a part for 2 slot time among the collision-avoidance time amount set up by the random numbers in fact since 1 slot time was added to 2 slot time in STA2 while AP transmits data and a part for 3 slot time is digested is digested, but, in the remaining parts, surroundings and ** collision-avoidance period Tcw becomes next back-off control with a part for 5 slot time (in order that three waiting slot time may enter in fact, it is equivalent to 8 slot time).

[0074] next, AP transmits the 1st data packet, after progress of DIFS (TD), when the high data packet of priority reaches AP from a cable network side, AP lengthens one value out of the random-number range 0-10 again, and "6" gives — having — ** — the following collision-avoidance time amount Tcw turns into 6 slot time. Result [Tcw of STA2 by which the 1st transmission was postponed is 5 slot time and it compared 6 slot time of this and AP] (6x slot time / 1.5) <(5x slot time) — (6)

Also in a next door and the 2nd back-off control, the direction of the collision-avoidance period of AP becomes short, and it will precede and transmit.

[0075] And when AP transmits the 2nd data packet, since 6 slot time is digested by AP, by STA2, 4 slot time is digested and, as for 5 slot time of STA2, **1 slot time (in fact, since 1 time of waiting slot time is contained, it is equivalent to 2 slot time) remains.

[0076] Next, after progress of DIFS (TD), rather than STA, when a data packet with still higher priority reaches AP from a cable network side, AP subtracts a random number out of the random-number range 0-10 to it, and obtains random-number value"3" to it. Thereby, Tcw of

**AP serves as 3 slot time.

[0077] By the way, in the 3rd transmission, the value of Tcw of low STA2 of priority is 1 slot time (it is 2 slot time containing one waiting slot time in fact), and they are AP, and STA2 and Tcw. (3x slot time / 1.5) > (1x slot time) — (7)

The data packet of STA2 is transmitted at last by the next door and the 3rd time of these. In this transmission, 2 slot time is digested and the collision-avoidance period of AP turns into 1 slot time.

[0078] Furthermore, in the 4th transmission, when the data packet which should transmit to STA2 occurs, STA2 subtracts a random number out of the random-number range 0-10, and obtains random-number value"4." Thereby, Tcw of **STA2 serves as 4 slot time (in practice, in order that two waiting slot time may enter, it is equivalent to 6 slot time).

[0079] Since waiting slot time is given once to the collision-avoidance period with the lower priority of a data packet to two slots according to these above operation gestalten, Priority compares with a high data packet. The low data packet of priority Even if the same random-number value is given, it sees and the slot time as upper Tcw is the same, the time amount actually digested becomes long 1.5 times, and the probability to transmit previously a data packet with priority high as a result becomes high.

[0080] Next, drawing 4 explains the 3rd operation gestalt of the wireless packet priority-control approach by this invention.

[0081] This operation gestalt is the approach of performing weighting to the range of a random number, without changing the digestive approach of modification of slot time or a collision-avoidance period like the 1st and 2nd operation gestalt mentioned above, and giving priority to the transmitting probability of a data packet by changing the generating range of a random number, collision avoidance is carried out and it is transmitted.

[0082] A short collision-avoidance period may be assigned to the terminal which is already going to transmit the low packet of priority from the random-number value lengthened first by not classifying the perfect random-number range according to the priority of data, and making the part which the range of each other overlaps from this operation gestalt.

[0083] As opposed to the collision-avoidance period Tcw being shortened only for the part which stood by transmission by the conventional approach instead, with this operation gestalt As opposed to the terminal which is going to transmit the low data packet of priority a collision-avoidance period it considered as the approach of adding the slot time equivalent to the minimum value of a random-number value in the collision-avoidance period of the 2nd henceforth fixed so that it might not become below the value that imposed slot time on the minimum value in the range of a random number always.

[0084] Concretely, as range distribution of this random number is shown in drawing 4 , in a collision-avoidance period Tcw setup, the terminal (for example, AP) which the terminal (for example, STA2) which is going to transmit the low data packet of priority tends to set to 3-10 the range of the random number given when making 3 slot time into fixed time amount, and is going to transmit the high data packet of priority sets up the random-number range given with 0-7. The probability which the terminal which is going to transmit the high data packet of priority can transmit first by this setup becomes high.

[0085] In this drawing 4 , the actuation to the condition that STA1 ends transmission of data, the high data packet of priority exists in AP, and the low data packet of priority exists in STA2 is the same as that of drawing 1 and drawing 3 which were mentioned above.

[0086] The actuation which performs the priority control of this operation gestalt sets up the random-number range of AP which is going to transmit the high data packet of priority with 0-7, and subtracts a random number from the inside. Moreover, the random-number range of STA2 which is going to transmit the low data packet of priority considers as the integer to 3-10, and subtracts a random number. By such setup, even if STA2 can give the minimum value, it becomes 3 slot time, and substantially, 3 slot time by the side of the head of a collision-avoidance period is the same as what is always being fixed.

[0087] Thus, in the low data packet side of priority, the fixed value of immobilization will surely be taken. In drawing 4 , if "4" is given to AP from the random-number range and "7" is given to

STA2 from the random-number range, **AP will serve as 4 slot time and **STA2 will serve as 7 slot time.

[0088] And when AP transmits the 1st data and the high data packet of priority reaches AP from a cable network side again, again, a random number is subtracted out of the random-number range 0-7, for example, "3" is given to the collision-avoidance period of **AP.

[0089] Moreover, in the collision-avoidance period Tcw, STA2 postponed in the 1st transmission digests only 4 slot time, and serves as remainder 3 slot time. However, among this 4 slot time, in back-off control, since it is the period for which it must wait, a part for 3 slot time is not counted as digested slot time. For this reason, the digested number of slots in the last back-off control becomes a part for 1 slot time, and a part for the remaining 3 slot time is carried over as time amount for which it must wait.

[0090] In the 2nd transmission, the collision-avoidance period Tcw in **STA2 turns into 6 slot time by which 3 slot time for which it must wait was added to 3 slot time which was not digested at the time of the 1st transmission. Moreover, in AP, a random number is subtracted out of the random-number range 0-7, for example, "3" is given. Thereby, also in the 2nd transmission of a data packet, the collision-avoidance period Tcw of AP becomes shorter than the collision-avoidance period Tcw in STA2, and transmission of AP is performed preferentially.

[0091] And the 2nd data packet is transmitted, after progress of DIFS (TD), when the high data packet of priority reaches AP from a cable network again, AP subtracts a random number out of the random-number range 0-7, "7" is given, and the collision-avoidance period Tcw of **AP turns into 7 slot time.

[0092] Moreover, as for the collision-avoidance period Tcw of **STA2, in the 2nd back-off control, although 3 slot time is digested and 3 slot time turns into residual time, the collision-avoidance period Tcw of this **STA2 turns into 6 slot time which added 3 slot time which turns into said residual time at 3 slot time which surely turns into the latency time.

[0093] Therefore, since the collision-avoidance period Tcw of STA2 turns into [the collision-avoidance period Tcw of AP] 6 slot time by 7 slot time, STA2 of time amount is shorter and data can be transmitted.

[0094] It is the approach of making it the probability for a data packet with high priority to be transmitted previously become high, by the priority-control approach of this 3rd operation gestalt preparing beforehand the waiting slot time which surely turns into the latency time in a head side fixed at the collision-avoidance period Tcw given to the terminal which is going to transmit the low data packet of the priority of a data packet, as explained above, and adding the slot time which was not digested by the last time except waiting slot time.

[0095] The above explanation described the case where the high data packet of priority was mainly transmitted to STA from AP, with the 1st thru/or 3rd operation gestalt. About a setup of the priority of the data from AP to STA, it is manageable unitary by AP. A setup of the priority of the data generated in each STA is carrying out in the procedure shown below, and becomes controllable as a system.

[0096] First, in order to enforce each priority-control approach explained in drawing 1, drawing 3, and drawing 4, all STAs need to notify the priority of the data packet, before transmitting a data packet to AP, and need to obtain the authorization to performing data packet transmission by the priority from AP further.

[0097] In advance of data packet transmission, STA1 and STA2 in drawing 1, drawing 3, and drawing 4 transmit to AP by making into a communication packet priority information considered to be the need in the data packet transmission.

[0098] First, AP which received the communication packet including priority information from STA1 and STA2 determines the priority permitted to STA1 and STA2 in consideration of the priority level demanded from whole traffic and whole STA, and transmits this as a communication packet by return to each STA.

[0099] And STA1 and STA2 perform a priority control by performing weighting in the generating range of a random number according to the priority information on the communication packet from this AP by the priority-control approach of the 3rd operation gestalt which shows the digestive approach of slot time in drawing 4 by the priority-control approach of the 2nd

operation gestalt which shows the die length of slot time in drawing 3 by the priority-control approach of the 1st operation gestalt shown in drawing 1.

[0100] By performing a setup of the priority by the communication packet between such AP-STA in advance of activation of a priority control, system control can be carried out so that each STA may acquire freely high priority and may not perform data transmission.

[0101] Thus, as for the priority-control approach of this invention, the priority of a data packet uses that the probability for the higher one to become [the probability for the die length of Tcw to become short] high, and to transmit previously a data packet with priority high as a result becomes high. It enables this to perform a priority control, with the features of a contention access control not lost.

[Translation done.]

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing for explaining the 1st operation gestalt concerning the wireless packet priority-control approach of this invention.
[Drawing 2] It is a flow chart for explaining the concept of the wireless packet priority-control approach of this invention.
[Drawing 3] It is drawing for explaining the 2nd operation gestalt concerning the wireless packet priority-control approach of this invention.
[Drawing 4] It is drawing for explaining the 3rd operation gestalt concerning the wireless packet priority-control approach of this invention.
[Drawing 5] It is drawing for explaining the conventional contention access-control DCF.
[Drawing 6] It is drawing for explaining the priority control using the DCF control by which the conventional proposal is made.
[Description of Notations]
Ts—SIFS
TD — DIFS
Tcw — Collision-avoidance period (Contention Window:Tcw)
P1 — Priority data packet
P2 — Data packet non-giving priority
AP — Base station
STA1, STA2 — Wireless terminal
TA — Slot time (slot time over a priority packet transmit terminal)
TB — Slot time (slot time over a non-giving priority packet transmit terminal)

[Translation done.]

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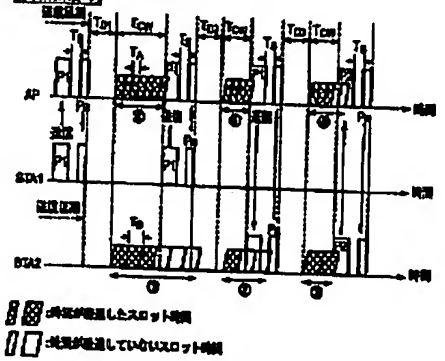
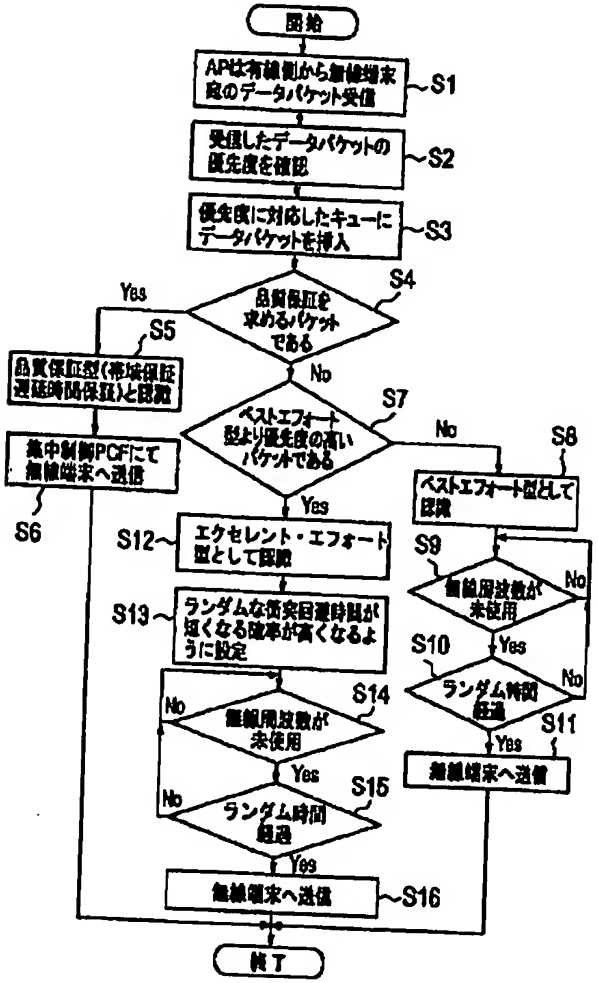
3.In the drawings, any words are not translated.

DRAWINGS

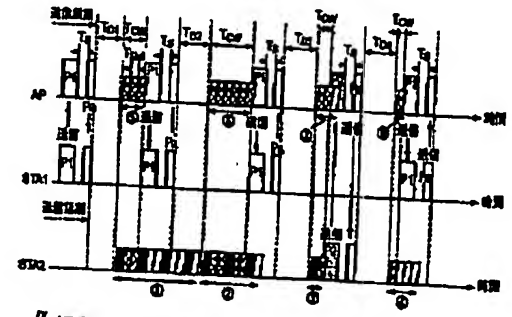
[Drawing 1]



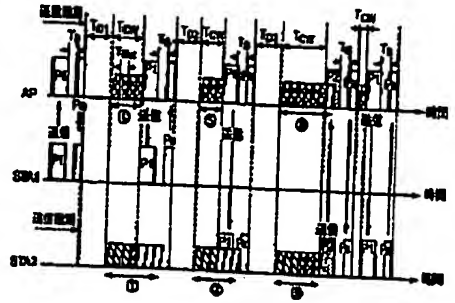
[Drawing 2]



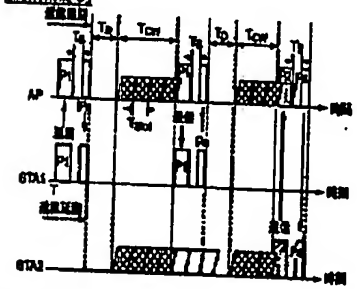
[Drawing 3]



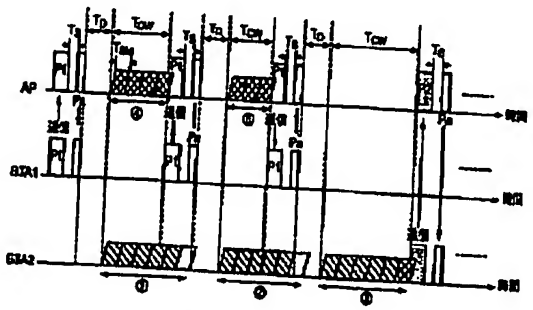
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

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